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Empathy in schizophrenia: impaired resonance

Haker, H ; Rössler, W

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ORIGINAL PAPER

Empathy in schizophrenia: impaired resonance

Helene Haker · Wulf Rössler

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Abstract Resonance is the phenomenon of one person unconsciously mirroring the motor actions as basis of emotional expressions of another person. This shared representation serves as a basis for sharing physiological and emotional states of others and is an important component of empathy. Contagious laughing and contagious yawning are examples of resonance. In the interpersonal contact with individuals with schizophrenia we can often experience impaired empathic resonance. The aim of this study is to determine differences in empathic resonance—in terms of contagion by yawning and laughing—in individuals with schizophrenia and healthy controls in the context of psychopathology and social functioning. We presented video sequences of yawning, laughing or neutral faces to 43 schizophrenia outpatients and 45 sex- and age-matched healthy controls. Participants were video-taped during the stimulation and rated regarding contagion by yawning and laughing. In addition, we assessed self-rated empathic abilities (Interpersonal Reactivity Index), psychopathology (Positive and Negative Syndrome Scale in the schizophrenia group resp. Schizotypal Personality Questionnaire in the control group), social dysfunction (Social Dysfunction Index) and executive functions (Stroop, Fluency). Individuals with schizophrenia showed lower contagion rates for yawning and laughing. Self-rated empathic concern showed no group difference and did not correlate with contagion. Low rate of contagion by laughing correlated with the schizophrenia negative syndrome and with social dysfunction. We conclude that impaired resonance is a handicap for individuals with schizophrenia in social life. Blunted observable resonance does not necessarily reflect reduced subjective empathic concern.

Keywords Contagion · Imitation · Laughing · Social cognition · Yawning

Abbreviations

cL	Contagious laughing
CPZe	Chlorpromazine equivalents
cY	Contagious yawning
IRI	Interpersonal Reactivity Index
IRI_EC	Empathic concern subscale of the IRI
IRI_FS	Fantasy subscale of the IRI
IRI_PD	Personal distress subscale of the IRI
IRI_PT	Perspective taking subscale of the IRI
MNS	Mirror neuron system
PANSS	Positive and Negative Syndrome Scale
SDI	Social Dysfunction Index
siL	Stimulus incongruent laughing
siY	Stimulus incongruent yawning
SPQ	Schizotypal Personality Questionnaire
ToM	Theory of Mind

Introduction

Empathic resonance is the phenomenon of one person unconsciously mirroring the motor actions as basis of emotional expressions of another person. This shared representation serves as a basis for the ability to share physiological and emotional states of others and makes up one component of empathy [19, 22, 42, 61]. Empathy is not a unitary function; it is more likely based on at least partially

H. Haker (✉) · W. Rössler
Department of General and Social Psychiatry,
Psychiatric University Hospital of Zurich,
Militärstrasse 8, POB 1930, 8021 Zurich, Switzerland
e-mail: haker@dgsp.uzh.ch

dissociable functional systems which can be divided into motor empathy, i.e., empathic resonance, a cognitive and an emotional part of empathy [4, 12, 13]. The cognitive part of empathy comprises the ability to understand and explain mental states of others (known as theory of mind, ToM), whereas the emotional part of empathy includes the own experience of the other person's actual or inferred emotional state. Resonance can be seen as a bottom-up input for the emotional and cognitive part of empathy and is mediated by shared representations in the mirror neuron system (MNS) and frontoparietal networks [14, 18, 26, 34, 47, 61]. This so-called perception-action link has also been referred to as "chameleon effect" [8, 42]: an unconscious mimicry of the postures, facial expressions, and other behaviors of one's interaction partners, such that one's behavior passively and unintentionally changes to match that of others in one's current social environment. It constitutes a basic way of getting in contact with another person.

This basic way of establishing contact can be impaired. When these subtle alterations in communication are experienced during contact with an individual suffering from schizophrenia, they subsequently lead to an intuitive diagnosis of schizophrenia. The Dutch psychiatrist Henricus Cornelis Rümke first mentioned this phenomenon in the literature in 1941. He used the term "praecox feeling" to describe "the inability to come in contact as a whole" with a person who suffers from schizophrenia [50]. We assume that this phenomenon is based on reduced resonance. This intuitive reasoning based on subliminal information is still used today by some psychiatrists in daily practice in addition to standardized diagnostic classification [21]. Impaired empathy has recently been assumed to be involved in schizophrenia [2, 19, 51, 54]. Long before, Karl Jaspers stated that a failure of empathy and understanding are common elements in diagnosing schizophrenia [23]. The "inability to come into contact as a whole" can indeed be a diagnostic tool for psychiatrists but is most notably a handicap for affected individuals in interpersonal communication in everyday life. Reduced resonance forms a barrier for interpersonal contacts and adequate social functioning [56] and has stigmatizing potential [17]. The hypothetical assumption of deficits in resonance as basis of the "praecox feeling" puts the specificity of the sign in question with respect to other diagnoses with altered social reciprocity such as schizotypal personality disorder or high functioning autism.

Contagious yawning (cY) and contagious laughing (cL) are easily observable signs of resonance as an interaction between two individuals, with one person experiencing and sharing the physiological and emotional state of the other. The implicit link between two persons in cY has been discussed in the literature as a sign reflecting the motor mimicry component of human empathy [33, 40, 41, 43, 53] and as evidence of empathic abilities in chimpanzees [1], and dogs [24]. Platek et al. [40] showed a correlation between higher scores on the Schizotypal Personality Questionnaire (SPQ) and lower rates of cY in a sample of undergraduate students. Recently, impairment in cY in children with autism spectrum disorder was reported by Senju et al. [55]. To the best of our knowledge, no study has examined cY and cL in individuals suffering from schizophrenia so far. We hypothesize that (1) cY and cL are impaired in individuals suffering from schizophrenia compared to healthy controls. Furthermore, we hypothesize that (2) a reduced ability to resonate—measured in terms of contagion—is associated with severe psychopathology and impaired social functioning in individuals with schizophrenia.

To test our hypotheses, we assessed two observable measures of empathic resonance (cY and cL) and one self-assessment measure of empathy (Interpersonal Reactivity Index, IRI) in individuals with schizophrenia and healthy controls. In both groups, we compared the ability to resonate with their psychopathology [i.e. with the Positive and Negative Syndrome Scale (PANSS) in individuals with schizophrenia, and with the SPQ in healthy controls]. In the schizophrenia group, we additionally compared the measures of resonance and the self-reported empathic abilities with the Social Dysfunction Index (SDI).

Methods

Participants

Forty-three individuals suffering from schizophrenia and 45 non-clinical healthy controls, matched for sex, and age, volunteered to participate in this study (Table 1). Individuals suffering from schizophrenia were clinically diagnosed according to ICD-10 and had to be in full or partial remission (ICD-10 F20.x4/.x5). Paranoid subtype, $n = 13$; hebephrenic subtype, $n = 1$; undifferentiated subtype, $n = 28$; residual type, $n = 1$. We verified the clinical diagnosis using the OPCRIT procedure for life-time

Table 1 Sample

Characteristics	Schizophrenia ($n = 43$)	Control ($n = 45$)
Women (%)	11 (26)	12 (27)
Age[a]	34 (10)	35 (11)
Education[b,c]	13 (2)	14 (2)
Age of illness onset[b]	24 (6)	
Duration of illness[b]	11 (9)	

[a] Mann–Whitney, $P = 0.84$

[b] Data are given in years, mean (SD), otherwise indicated

[c] Mann–Whitney, $P = 0.002$

diagnosis [3]. All individuals with schizophrenia received antipsychotic medication (amisulpiride, aripiprazole, clozapine, flupenthixole, olanzapine, quetiapine or risperidone; mean chlorpromazine equivalents (CPZe) 297 (SD 178); CPZe for second generation antipsychotics were calculated as suggested by Woods [63]. The controls were not-hospitalized healthy participants without psychiatric history and free of psychopharmacological medication.

The study was approved by the local ethical committee and conducted in accordance with the guidelines of the Helsinki Declaration. All participants have given written informed consent.

Resonance

Contagion

All participants were exposed to 24 video sequences (each 15 s) in a randomized order presented on a 17′ screen. The video sequences showed yawning, laughing and "neutral" faces (Fig. 1). The video sequences were recorded with 16 volunteers, with 8 sequences of each condition (four men, four women) and 8 volunteers in the 2 different conditions.

Participants were instructed to relax and to imagine a situation in a waiting room sitting vis-à-vis another person. They should imagine a situation in which they are aware of the other person but not in verbal contact. They were further instructed not to suppress any effect the other person's behavior might have on them. After each sequence they were asked to answer two distractor questions, which were shown on the computer screen: How comfortable they felt viewing the sequence and how likeable they found the person in the sequence (both on a 5-step Likert scale from "not at all" to "very much"). While the study participants watched the sequences, their faces were recorded on videotape. The total duration of the experiment was about 25 min.

The video recordings were each rated by two clinical psychologists not related to our institution. They were blind to our hypotheses, to the different groups assessed, and the stimulus quality. Inter-rater reliability was high (Cohen's kappa = 0.89). A contagion was rated as soon as a minimal sign of yawning/sighing or laughing/smiling was detected even without fully apparent yawning or laughing. Stimulus-congruent responses (cL/cY) were counted as contagions. Stimulus-incongruent laughing or yawning responses (siL/siY) were analyzed separately. A similar setup has been used by Platek et al. [40].

Interpersonal Reactivity Index

The IRI is a self-report measurement of empathy [10]. It includes four subscales, each ranging from 0 to 28: (1) Fantasy scale (IRI_FS), which measures a tendency to fantasize about fictional characters; (2) Empathic concern (IRI_EC), which specifically addresses the respondents' capacity for concerned and compassionate feelings for others; (3) Perspective taking (IRI_PT), addressing ToM abilities; (4) Personal distress (IRI_PD), which records self-oriented responses to difficult situations of others. The questionnaire takes 15 min to complete.

Psychopathology

Positive and Negative Syndrome Scale

In schizophrenia patients the degree of psychopathology was assessed using the PANSS, comprising the positive and negative syndrome scale (each ranging from 7 to 49) and the general psychopathology scale (ranging from 16 to 112) [25]. The two semi-structured interviews (PANSS and SDI, see "Social functioning") took between 45 and 60 min to assess. The interviews were rated by an experienced psychiatrist and clinical psychologist. They had been trained together and they obtained an inter-rater reliability of 0.86 (Cohen's kappa).

Schizotypal Personality Questionnaire

To assess "psychopathology" in healthy controls we used the SPQ overall score (0–74) [44] assuming that

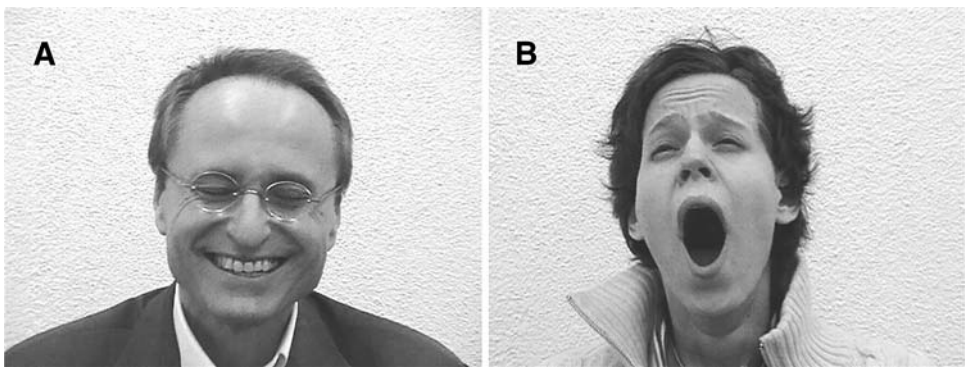

Fig. 1 Two stills of the video stimuli: **a** laughing and **b** yawning

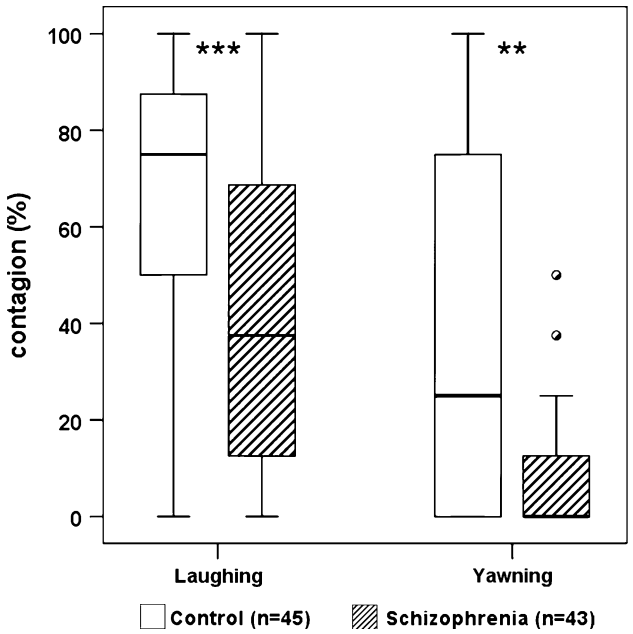

Fig. 2 Contagion by laughing and by yawning in percent for the control and the schizophrenia group. The length of the box is the interquartile range (*IQR*) computed from Tukey's hinges. The median is identified by a line inside the box. Values of more than 1.5 IQRs but <3 IQRs from the end of the box are labeled as outliers (*open circles*). Significant group differences (Mann–Whitney) are indicated with asterisks (**$P < 0.01$, ***$P < 0.001$)

schizotypal personality traits represent subclinical symptoms of psychosis [49]. The SPQ consists of 74 yes/no questions and takes 15 min to complete [28]. Raine reported a mean total score of 26.6 (SD 10.1) as norm [45].

Social functioning

Social Dysfunction Index

The SDI assesses social dysfunction in nine components: public self; independent living; occupational functioning; family relationships; important relationships other than family; community leisure recreation; acceptance and adherence to health regimens; communication; locus of control. The SDI accounts for the severity and number of areas of dysfunction. It was developed for individuals with schizophrenia or other severe mentally illness [38]. The overall dysfunction score is calculated as a percentage of total possible score. Higher scores indicate a higher degree of social dysfunction.

Executive functions

Stroop test

Cognitive flexibility and interference was assessed with the Stroop test [59] in the list version described by Perret [39, 57]. It consists of three cards, each containing six rows of four items: first, dots printed in blue, green, red, or yellow in a pseudorandom order with each color appearing once in each row. On the second card, dots are replaced by common words, and on the third card, the common words are replaced by color names (blue, green, red, yellow) so that the print color never corresponds to the color name. Participants were instructed to call the color name (of the dots, the words or the color names) as quickly as possible. For each part, the time and the number of errors were recorded.

Verbal fluency

Phonemic verbal fluency was assessed, according to Regard [46], by asking the participants to produce as many different words as possible that begin with the letter "S" within 3 min. Participants were instructed not to produce proper nouns or repeat words. The total number of words produced the number of repetitions, and the number of wrong words (beginning with another letter) was recorded.

Figural fluency

Nonverbal fluency was assessed with the five-point test [46]. The test items appear on a sheet, partitioned in rectangles. Five symmetrically arranged black dots are printed in each rectangle. The participants were asked to produce as many different figures as possible within 3 min. by connecting the given dots in each rectangle with straight lines. The variables scored were the total number of figures, the number of repetitions and the number of incorrect figures.

Data analysis

Statistical analyses were carried out using SPSS 16.0 statistical software for Windows (SPSS Inc., Chicago, IL, USA). Because some of our continuous measures were clearly non-normally distributed (Kolmogorov–Smirnov test: $P < 0.10$), we chose the Mann–Whitney nonparametric test to compare the group differences. To remain consistent, the Mann–Whitney test was applied throughout. Bivariate Spearman correlations were computed to assess the relationship between contagion, self-report, psychopathology, social dysfunction and executive functions. The linear-weighted kappa statistic was used to evaluate inter-rater reliability (Cohen's kappa).

Results

The analysis of the distractor task revealed that the video stimuli did not significantly differ among each other

Table 2 Results

	Schizophrenia ($n = 43$)	Control ($n = 45$)	Mann–Whitney U	P value
Resonance				
Contagion by laughing (cL)[a] (%)	39.8	71.9	440	<0.001
Contagion by Yawning (cY)[a] (%)	15.4	38.3	638	0.003
Stimulus-incongruent Laughing (siL)[a] (%)	26.2	40.6	634	0.005
Stimulus-incongruent Yawning (siY)[a] (%)	3.8	6.4	865	0.236
Interpersonal reactivity index				
Fantasy scale	14.5 (5.3)	16.6 (6.2)	738	0.05
Empathic concern	18.3 (4.6)	19.2 (4.5)	846	0.31
Perspective taking	16.1 (4.3)	18.2 (4.2)	687	0.02
Personal distress	14.8 (5.2)	11.9 (5.1)	675	0.01
Psychopathology				
Schizotypal personality questionnaire		9.9 (8.6)		
PANSS	53.1 (14.1)			
Positive	12.2 (3.6)			
Negative	14.6 (6.2)			
General	26.3 (7.5)			
Impairments in social functioning				
Social dysfunction index	0.33 (0.15)			
Executive functions				
Stroop index	1.8 (0.4)	1.8 (0.4)	0.2	0.656
Verbal fluency	24.47 (8.4)	33.1 (10.1)	18.8	<0.001
Figural fluency	31.8 (10.7)	43.2 (11.9)	22.2	<0.001

See the distribution in Fig. 2

PANSS positive and negative syndrome scale

[a] Data are not-normally distributed and given as the median (each with min = 0, max = 100)

concerning the participants' rating for "comfort viewing the video" and "likeability of the person". We found neither significant difference in the contagiousness of the single stimuli.

Group differences

The ratings of the laugh and yawn videos for "comfort viewing the video" and "likeability of the person" showed no differences between the groups.

Table 2 shows the results of contagion, psychopathology, social dysfunction and executive functions of the schizophrenia and the control group. There are significant group differences in contagion (cY and cL) and on two subscales of the IRI (Perspective taking, IRI_PT and Personal distress, IRI_PD). Controls showed more contagion and reported more perspective taking abilities, whereas individuals with schizophrenia reported higher personal distress. We found no significant differences between the diagnostic subtypes in the schizophrenia group. The schizophrenia and the control group reported a comparable degree of Empathic concern (IRI_EC). Neither contagion nor IRI correlated with medication (in CPZe). We found no differences between the various antipsychotics. Since we found no correlation between education and the variables of interest (contagion, IRI), we did not consider the significant difference in the vocational education between the two groups (Table 1). Concerning executive functions, the control group performed better on the two fluency tasks. Both groups performed equally regarding the Stroop index (Table 2). Since the proportion of women in both groups was to low (12%), we considered it as statistically not reasonable to calculate sex differences.

Correlation of observed contagion with psychopathology and social dysfunction

Control group

The mean score of the SPQ in the control group was low and the distribution was narrow ($m = 9.9$, SD = 8.8, min = 0, max = 31) compared to the original population described by Raine ($m = 26$) [45] Therefore, calculating correlations over the SPQ continuum with social functioning within the control group seemed not to be reasonable.

Table 3 Correlations, Schizophrenia Group ($n = 43$)

	cL	cY	IRI_FS	IRI_EC	IRI_PT	IRI_PD
Contagious laughing (cL)		**0.332***	**0.344***	0.170	0.183	0.015
Contagious yawning (cY)	**0.332***		0.100	−0.015	0.041	−0.014
IRI fantasy scale (IRI_FS)	**0.344***	0.100		**0.459****	**0.387****	0.064
IRI empathic concern (IRI_EC)	0.170	−0.015	**0.459****		**0.565*****	**0.329***
IRI perpective taking (IRI_PT)	0.183	0.041	**0.387****	**0.565*****		0.024
IRI personal distress (IRI_PD)	0.015	−0.014	0.064	**0.329***	0.024	
PANSS	−0.231	−0.193	0.045	0.112	−0.237	**0.322***
Positive scale	−0.142	0.046	−0.051	−0.056	−0.110	0.179
Negative Scale	**−0.348***	−0.230	0.021	0.170	−0.213	**0.352***
General psychopathology scale	−0.078	−0.194	0.091	0.096	−0.215	0.228
Social dysfunction index	**−0.303***	−0.143	−0.095	0.011	−0.141	0.246
Verbal fluency	0.019	0.072	0.290	0.082	0.207	−0.174
Figural fluency	−0.080	0.267	−0.043	−0.114	0.036	0.019
Stroop index	0.085	0.011	−0.197	−0.049	0.059	−0.143

Data are given as correlation coefficient r

* Correlation is significant at the 0.05 level, ** at the 0.01 level, *** at the 0.001 level

Schizophrenia group

In the schizophrenia group, cL correlated negatively with the PANSS negative scale ($r = -0.348$, $P = 0.02$) and the SDI ($r = -0.303$, $P = 0.05$) (Table 3; Fig. 3). The correlation with the SDI was based on one single domain: *SDI_4* "dysfunction in family relationships" (cL $r = -0.472$, $P = 0.001$; cY $r = -0.331$, $P = 0.03$). A positive correlation was seen between the IRI Personal distress scale and the PANSS negative scale. No significant correlations between the measures of resonance and the executive functions.

We are aware of the problem of multiple testing. As this is the first study of this kind, we decided not to raise the significance level, as not to exclude potential interpretations for future research. The correlations are therefore reported without correction. The correction according to Bonferroni revealed a statistical trend ($P = 0.085$) in the correlation of cL with *SDI_4* (family relationships). Other correlations did not reach the level of significance.

Stimulus-incongruent responses

Stimulus-incongruent laughing (siL; as response to a yawning or neutral stimulus) occurred in 41%, respectively, 26% (control vs. schizophrenia group, $U = 633$, $P = 0.005$). A stimulus-incongruent yawning (siY; as response to a laughing or neutral stimulus) was observed in 6%, respectively, 4% (n.s.).

The stimulus-incongruent responses correlated with the stimulus-congruent responses (i.e. cL and cY) as follows: In the control group correlation of siY with cY ($r = 0.539$, $P < 0.001$). In the schizophrenia group correlation of siL with cL ($r = 0.594$, $P = 0.001$).

In the schizophrenia group, siL correlated in a negative way significantly with the PANSS negative scale (siL: $r = -0.408$, $P = 0.007$) and with the dosage of antipsychotics (in CPZe) (siL: $r = -0.330$, $P = 0.04$). No correlations were seen between incongruent laughing and yawning responses with social dysfunction or executive functions.

Correlation of observed contagion with self-reported empathic abilities

Only one of the four IRI-subscales showed a significant bivariate correlation with the measures of contagion: The IRI Fantasy scale correlated with cY in the control group ($r = 0.378$, $P = 0.010$) and with cL in the schizophrenia group ($r = 0.373$, $P = 0.014$).

Discussion

We compared the ability to resonate (observable contagion and self-report) in individuals with schizophrenia with healthy controls in the context of psychopathology and social functioning. We hypothesized a lack of cL and cY in the schizophrenia group and an association between the lack of contagion and impairments in social functioning.

Group differences in contagion

Our first hypothesis was confirmed by the main finding in our study: the significant reduction of cL and cY in the

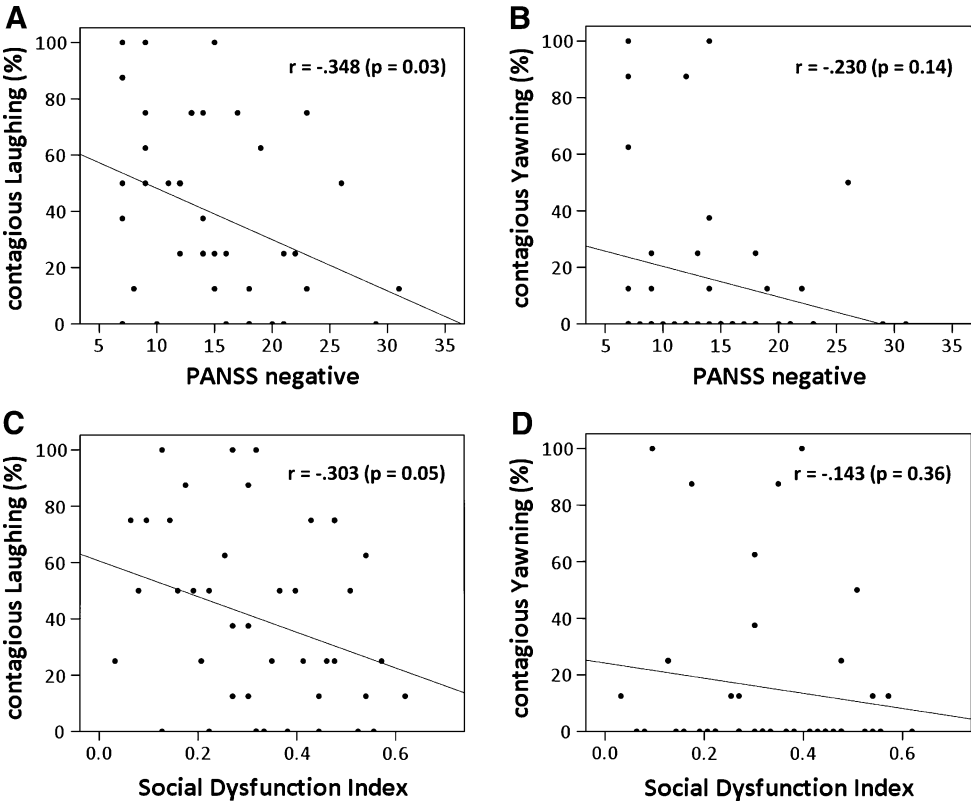

Fig. 3 Scatter plots of contagion data of the schizophrenia group plotted against the PANSS negative scale (**a**, **b**) and the SDI (**c**, **d**), respectively

schizophrenia group compared with healthy controls. The mean incidence rate of cY in our control group (38.3%) matches the 41.5% reported by Platek et al. [40].

The impaired contagion as a sign of empathic resonance in the schizophrenia group can be explained by different influences, in particular by psychomotor constrictions due to illness or medication. We may state, that we found no significant correlation of medication dosage (in CPZe) and contagion. Executive cognitive functions were as expected impaired in the schizophrenia group but did not correlate with contagion. The analysis of stimulus-incongruent laughing and yawning (siL, siY) allows an inference on the overall psychomotor activity of the participants. The group difference with less response in the schizophrenia group is seen in siL but not in siY. A negative influence of general illness related factors such as negative symptoms or medication (in CPZe) is also seen in siL but not in siY. Furthermore in the schizophrenia group, siL correlates significantly with the intended contagion (cL). This means that the recorded laughing in the schizophrenia group was not specific to the phenomenon of contagion but might reflect the general level of unspecific social responsiveness, psychomotor activity, or attention. In contrast, siY—as a general disposition to yawn—correlated not with cY, and showed no influence of psychopathology or medication. We see this as an indicator of a higher specificity of the more basal yawning stimulus. The situation is inverted in the control group. Here, cL is not the continuation of the high level social responsiveness reflected by siL, but is distinct by the specific stimulation. Our interpretation is that in the control group, the (preexisting high) laughing response is highly modulated by the external stimulation. We assume that this effect is not only due to contagion but also other (possibly social-cognitive) factors which are more pronounced in the control than in the schizophrenia group. One possible explanation for the unspecific yawning response in the control group (i.e. high correlation between siY and cY) could be a gating effect: a reinforcement of the automatic process of contagion by repetitive stimulation. The initial lower level of contagiousness may hamper this gating mechanism in the schizophrenia group.

Furthermore, one might discuss if individuals with schizophrenia feel more uncomfortable in the test situation, thus reducing their ability to resonate. However, our analysis of the distractor task data showed that there was no significant difference between the two groups in their judgment how comfortable and likeable the stimulation was.

Psychopathology and social functioning

Due to the homogenous low scoring of our control group on the SPQ (compared to the original population described by Raine [45], the variance was too low to answer our

question about association of reduced contagion with schizotypal symptoms in the control group. The lack of contagion in the schizophrenia group responds to the clinical impression of the illness, and is reflected in the negative correlation of cL with the PANSS negative scale. However, the overall PANSS scores of our sample were rather low, corresponding to full or partial remission, thus, restricting our conclusion to less severe psychopathological states. As stated above, cY seems to detect variances (partly) independent of obvious psychopathology and points towards an underlying phenomenon, whose embedding in the common concepts of empathy has further to be discovered. It has further to be studied, how impairments of cY are related to an experienced psychiatrist's praecox feeling.

To the best of our knowledge, this is the first empirical evidence about the contribution of empathic resonance on social functioning in schizophrenia. Other empathic abilities such as the ToM (part of the cognitive part of empathy) have already been studied and are known to be impaired in schizophrenia and to contribute to the variance of social functioning [5, 7, 35, 48]. The negative correlation of cL with the SDI gives some support to our second hypothesis. However, we see this correlation only in one stimulus condition and it is of low significance. The correlation is based on clearly significant correlations of cL and cY with only one domain: dysfunction in "Family relationships". A lack of contagion in individuals with schizophrenia seems to occur mainly in close social contacts within the family circle. Social networks of individuals with schizophrenia consist largely of unidirectional therapeutic relationships. By contrast, family members have their own interpersonal needs and desires in face of their impaired relative. This may make this domain especially vulnerable to interpersonal challenges [31, 37]. However, an interpersonal handicap due to impairments in resonance leaves room to be coped/for rehabilitation in many domains of social life.

Self-report

The observable signs cY and cL are perceived in daily contact as nonverbal statements in social interaction. The absence of these signs leads us to make psychopathological interpretations about the affective state of the observed individual, and it may lead us to speculate about a deficient perception of social-emotional information. The interpretation of self-report measures in individuals with schizophrenia is limited, since deficits in ToM may affect the representation of own mental states [16]. Nevertheless, it is the most direct way to understand the subjective experience of an affected individual.

The IRI was already used for individuals with schizophrenia in a recent study by Montag et al. [36]. The results of our study replicate the group differences reported by Montag et al.: individuals with schizophrenia reported less perspective taking and more personal distress in response to difficult situations of others compared to healthy controls. No group difference was found on the Fantasy scale, in measuring the ability to fantasize about fictional characters and in empathic concern.

The reduced subjective perspective taking ability is in line with objective findings on ToM deficits reported in the literature [6, 16, 58] and evidence of a certain insight into social cognitive deficits. Unimpaired empathic concern combined with increased personal distress suggests that the perception of social-emotional content may be intact but cannot be processed adequately, suggesting a problem of the output and not predominantly of the input. This view was already expressed by Kring et al. [29, 30] and supported by facial emotional EMG findings. A core process involved in the handling of social-emotional information is the distinction between self and other. This function is known to be impaired in schizophrenia [9, 11, 20, 60]. On the one hand this can lead to a dysfunction of action attribution, contributing to positive symptoms such as verbal hallucinations or delusions of control [15, 27, 52, 62]. On the other hand, it can lead to difficulties in attributing shared representations, e.g., social-emotional information, which can produce self-oriented responses such as personal distress to difficult situations of others [32]. The positive correlation between the "personal distress" scale and the PANSS negative scale indicates the stressful component of a clinically blunted affect.

The comparison of the observed contagion with the self-report in our sample revealed only a minor association: only one of the four subscales of the IRI, the Fantasy scale, showed a significant correlation with contagion on the behavioral level. Particularly the two scales Empathic concern and Personal distress, that one could expect to be the most influenced by motor empathy regarding contagion, showed no correlation. The absence of this correlation in both groups suggests its being a general dissociation between behavioral and experiential response, rather than an expression of illness-related lack of insight.

Clinical implications

The observation of the ability to resonate is implicitly part of each clinical examination. It may even serve as an intuitive diagnostic instrument for schizophrenia, and is possibly related to the so-called "praecox feeling" [50]. This intuitive notice is more subtle than the clinical identification of negative symptoms. To what extent our low contagion data resemble a clinician's praecox feeling has yet to be determined. Rümke, who first described this clinical phenomenon [50], already mentioned the problem of subjectivity

when considering the "praecox feeling". An "objective" measurement of resonance using defined and invariant contagious stimuli (e.g. video sequences) allows controlling for (counter-) transference in personal contact—not in the Freudian sense, but in the sense of mutual resonance.

Limitations and suggestions for further research

We cannot discuss depressive numbness as reason for impaired resonance in consequence of lacking clinical rating for depression. Likewise, subjective tiredness as reason for facilitated cY was not assessed and limits the interpretation of the data.

Since this is a cross-sectional examination, we cannot predict if the so measured resonance is a state or a trait. Regarding the lack of Resonance in the (at least partial) remission state of our sample, reflected in low PANSS scores, we could speculate that this impairment is not state-dependent. A retesting or longitudinal study is needed to evaluate contagion over time and in various psychopathological states.

We are aware of the problem of multiple testing. As this is the first study of this kind, we decided not to raise the significance level, as not to exclude potential interpretations for future research.

Our explanations of the differences between cY and cL are only speculative. We used these two phenomena in our study presuming a common basis. Up to now, we can only hypothesize about top down cognitive influences that make laughing more contagious and yawning a purer resonance stimulus. The examination of the two stimulation conditions together with social-/cognitive parameters could provide further information about their differences. The combination of contagion response with a broader spectrum of other empathy-related functions (e.g. ToM, self-other distinction, emotional tasks) stimuli is needed to integrate these easily observable signs in the diverse conceptions of empathy.

Our paradigm could be used to further investigate the role of the MNS in schizophrenia [2, 19, 51]. Furthermore, imaging studies could reveal differences in the neural substrates of cY and cL.

On the level of clinical use, a cY test with higher resolution in the lower range could reveal further insight into the group of most impaired individuals.

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